

his Return home at Night to the *Devizes*, he fell from his Horse 3 or 4 times, and was at last taken up by a Neighbour, and put to Bed in a House upon the Road. He soon fell asleep; when, as he tells the Story himself, dreaming that he was fallen into a Furnace of boiling Wort, it put him into so great an Agony of Fright, that, struggling with all his Might to call out for Help, he actually did call out aloud, and recovered the Use of his Tongue from that Moment as effectually as ever he had it in his Life, without the least Hoarseness remaining, or Alteration in the old Sound of his Voice, as near as can be discerned. He was not used to drink hard; he is still alive, continues in good Health, and has the Use of his Tongue as perfectly as ever he had in the former Part of his Life.

IV. *Extract of a Letter from Mr. William Arderon, F. R. S. to Mr. Henry Baker, F. R. S. concerning the Hearing of Fish.*

S I R,

Read Feb. 11.
1747-8.

AS it was at your Desire that I set myself to make Experiments and Observations on the Nature and Properties of Fish, and to discover, if possible, whether they are sensible of Noises, and of the Motions of Bodies, by Hearing, in the Manner of Land Animals; or whether, being destitute of that Sense, the Want of it is supplied by the Quickness of their Sight and Feeling; I am going to lay before you the Method I made

use of to come at some kind of Certainty in this doubtful Affair; and shall think my Time has been well employed, if it can afford you any Satisfaction.

Tho' Fishes are not provided with Organs for Hearing, similar to those serving to that Purpose in other Animals, it would be too presumptuous to declare, without Experiment, that they are unable to hear, by Organs differently placed, whose Situation and Structure, for want of due Examination, we are unacquainted with.

In order therefore to be able to judge from real Facts, without being in the least prejudiced by what has been written for or against their Capacity of Hearing, I have, for almost three Years past, been continually trying Experiments on several Kinds of Fishes; *viz.* Perches, Ruffs, Bansticles, Millers Thumbs, Minnows, &c. which I have kept in Glass Jars for that Purpose; and at the Hours of feeding them, as well as at other Times, have, by different Noises, such as Whistling, Halloing, the Sounds of several musical Instruments, and every other means I could contrive, endeavoured to discover their Sense of Hearing, if they were indeed endowed with that Sense; but could never perceive they were affected by any of these Noises.

But whether Fishes do or do not hear, it is certain their Senses of *Feeling* and *Seeing* are exquisitely quick; and I believe, by the extreme Sensibility of these two, one may explain most of the Accounts that have been brought by Writers as Proofs of their Hearing; such as their coming, when called by their Names, as *Plutarch* relates of *Marcus Crassus's* Lamprey; their flocking in Throngs
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when called to be fed, as Mr. *Bradley* tells us he saw the Carps do in the Pond of one Mr. *Eden* at *Rotterdam*; and their flying away from the Halloing and Noises made by Sailors, as *Wolfgangus* reports the Dolphins do, when the Sailors have a Mind to fright them. — But may we not as reasonably imagine these Dolphins fly from the Sailors, their Ships and Boars, on account of the violent Action wherewith such Halloings usually are performed, as merely on account of the Noise they make? And in the other Cases, is it not as probable, that the Fish in Ponds, either by their Sight or Feeling, discover'd the Approach of their Benefactors, whose coming they were accustomed to expect, as that they were sensible of their Voices calling them?

I have often struck with my Thumb-Nail against the Edge of a glass Jar, in which I kept two Ruffs, a Stroke not harder than the Beat of a Pulse, which would cause them in a Moment to dart from the Bottom of the Jar to the Top; tho' I am sure they did not see me. But if I made the same Motion without hitting the Glass, or if I made an hundred times louder Noises than the striking of my Nail against the Glass, at a very small Distance from it, I could not perceive they were in the least affected thereby; which, if duly consider'd, may I think amount to a Proof of the Deafness or Want of Hearing in this kind of Fish at least; and that their delicate Sense of Feeling supplies them with the Knowledge of the Motions of Bodies, when their other Senses fail. Indeed I have often been convinced by Experiment, that their Feeling is exceedingly acute, perhaps more so than in other Animals; whence I have been led

to imagine, that their Fins may possibly be the Organs more immediately sensible of the slightest Motions in the Medium wherein they dwell. The Curious, who have observed the Fins of Fishes with the Microscope, find them to be composed of infinitely fine Vessels, Arteries, Veins, Muscles, and membranous *Fibrillæ*, whose Structure seems more delicate than is necessary for Parts that serve only as Oars to waft the Fish along. This however I desire you to regard as a mere Conjecture, for which the necessary Proofs are wanting.

At other times, if, by striking on the Top of the Jar with a small Key, the Stroke or Tremor has been a little more violent, the Fish would shut down their back Fins in a Moment, and remain motionless at the Bottom of the Glass. The sudden Appearance of my Hand at the Top of the Jar would likewise produce the same Effect; but Noises made near them seemed to give them no Disturbance.

These Experiments I have often repeated before several of my Acquaintance, as well as by myself in private, and seldom found them to vary much. But Fish newly taken out of Ponds, or Rivers, must not be expected to perform all I here relate: For they, like Birds just taken in the Fields, and put in Cages, are thrown into Confusion at the Approach of any thing, and endeavour continually to regain their Freedom.

If the Eyes of Fishes be carefully examined, when swimming in a glass Vessel, the *Cornea* or black *Uvea* of their Eyes may be seen, sometimes advancing forwards, and at other times retiring back, just as their Sight is directed to near or distant Objects,

jects, through a grosser or finer Medium; the Form of their Eyes altering, as the Occasion requires, to make them distinguish Objects; and their Eyes have so great a Liberty in the Orbits, that they are able to turn them any Way, upwards, downwards, to one Side or the other, nearly a Quarter of a Circle, which makes them full amends for the want of Motion in their Necks, and enables them to change or direct their *Optical Axis* to any designed Place in a Moment.

Those who have been accustomed to Fly-Fishing can bear Witness, that the Sight of Fishes is quick and distinct almost beyond Belief: For it is not uncommon to behold a Fish dart itself 20 or 30 Yards in an Instant at a Fly thrown out at the End of a long Line, and catch it even before it can well touch the Water. Few other Creatures are perhaps capable to distinguish Objects so small at so great a Distance, at least not so perfectly as these do; for, let the artificial Fly differ in Colour, Shape, or Bigness but very little from the natural one it should represent, and not a Fish will meddle with it.

These Instances of the exquisite *Feeling* and *Seeing* of Fishes, together with their Want of Organs that can be certainly known to serve them for *Hearing*, as well as of sufficient Facts to prove that they do hear, may, I think, amount to the highest Probability, that they are really destitute of that Sense *, and stand in no need thereof, notwithstanding

* 'Tis not hereby denied, that Fishes of the cetaceous Kind may probably hear, as well as some other Kinds produced in the Sea, that have Parts in common with Land Animals. These Observations are confined to the common Fish of our Rivers.

standing the contrary Opinions of some Authors: And their living in an Element, where Land Animals are capable of remaining but a very short time, may render an absolute Certainty in this Case unattainable.

But in order to discover what Land Animals can do, or what Fish, had they Organs of Hearing similar to those of Land Animals, would be capable of doing, I endeavoured last Summer to find out by Experiment,

First, Whether or no Sound made in the open Air can be heard by a Land Animal immersed under Water.

Secondly, Whether, and in what Manner, Sound made under Water can be heard by a Land Animal in the open Air. And,

Thirdly, Whether, and in what Manner, Sound made under Water can be heard by a Land Animal that is likewise under Water.

To satisfy my first Inquiry, whether Sound made in the open Air can be heard by a Land Animal under Water; I caused three People, stript quite naked, to dive down at the same time, and to remain about two Feet below the Surface of the Water; in which Situation I spoke to them as loud as I was able. At their coming above Water, they repeated my very Words, but said I spoke very low.

I caused the same Persons afterwards to dive down about 12 Feet under Water, and a Gun was discharged over them, which they all said they heard, but that the Noise was scarce perceivable.

As to my second Inquiry, Whether, and in what Manner, Sound made under Water can be heard
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in the open Air: I caused a young Man to dive some Feet down, and then to endeavour to halloo, which he did; and I could hear him, though very faintly. But imagining the Sound might come up with the Water he discharged at his Mouth whilst he halloo'd, I contrived a kind of Hand-Granado, which I threw into a Place in the River about nine Feet deep. The Fuzee burnt under Water near 10 Seconds, and then the Granado went off, giving a prodigious hollow Sound, and shaking the adjacent Ground to such a Degree, that the Whole of a large Building, some Yards distant from the Explosion, was put into a Tremor, far beyond what could be expected from so small a Quantity of Powder.

I satisfied my third Inquiry, Whether, and in what Manner, Sound made under Water can be heard by a Land Animal that is likewise under Water, by procuring a young Man to dive down with a Bell in his Hand; and he assured me, that he heard its tinkling very distinctly, at all Depths under Water, with little or no Difference from what he did when rung in the open Air: He likewise affirmed, that he plainly heard the Noise and Rushing of the Water, which came violently through a Flood-Gate, about 20 Feet distant from the Place he then was in.

If these Experiments and Observations may be thought deserving Notice, I shall think my Time not thrown away; but at all Events be assured, that I am,

Dear Sir,

Norwich, Nov. 27.

1747.

Your most obliged humble Servant,

W. Arderon.